

(12) **United States Patent**
Newase et al.

(10) **Patent No.:** **US 9,362,075 B2**
(45) **Date of Patent:** **Jun. 7, 2016**

(54) **COVER ASSEMBLY FOR CIRCUIT BREAKER, CIRCUIT BREAKER HAVING THE SAME, AND METHOD**

(56) **References Cited**

U.S. PATENT DOCUMENTS

(71) Applicant: **General Electric Company**,
Schenectady, NY (US)

(72) Inventors: **Yatin Vilas Newase**, Pune (IN);
Maddela Rajesh Babu, Secunderabad
(IN); **Janakiraman Narayanan**,
Secunderabad (IN); **Devendra Kumar**
Sharma, Secunderabad (IN)

(73) Assignee: **General Electric Company**,
Schenectady, NY (US)

3,784,940 A * 1/1974 De Torre H01H 83/02
335/18
4,827,231 A * 5/1989 Cheski H01H 71/04
335/17
4,975,667 A * 12/1990 Morgan H01H 71/0257
200/293
5,483,213 A * 1/1996 Mueller H01H 71/08
335/132
6,184,763 B1 * 2/2001 DeGrazia H01H 71/0264
335/172
6,205,019 B1 3/2001 Krom
6,295,190 B1 * 9/2001 Rinaldi G01R 31/3274
361/115
7,586,738 B1 9/2009 Hartzel et al.
8,519,287 B2 8/2013 Raabe et al.
2005/0109596 A1 * 5/2005 Quintanilla H01H 9/0264
200/293

(*) Notice: Subject to any disclaimer, the term of this
patent is extended or adjusted under 35
U.S.C. 154(b) by 304 days.

FOREIGN PATENT DOCUMENTS

CN 201117600 Y 9/2008
CN 202231335 U 5/2012

(Continued)

(21) Appl. No.: **14/094,938**

(22) Filed: **Dec. 3, 2013**

(65) **Prior Publication Data**

US 2015/0155113 A1 Jun. 4, 2015

(51) **Int. Cl.**
H01H 9/02 (2006.01)
H01H 71/02 (2006.01)
H01H 71/12 (2006.01)
H01H 71/08 (2006.01)

(52) **U.S. Cl.**
CPC **H01H 71/0207** (2013.01); **H01H 71/125**
(2013.01); **H01H 71/08** (2013.01); **Y10T**
29/49227 (2015.01)

(58) **Field of Classification Search**
CPC H01H 9/02; H01H 11/00
USPC 361/806; 335/202; 200/293
See application file for complete search history.

OTHER PUBLICATIONS

PowerWorx Advantage Series 3 RU High Current Circuit Breaker/
Fuse Power Distribution Panel; User Manual; ADCP-80-530, Issue 4;
Sep. 2010; Copyright 2010, ADC Telecommunications, Inc.

Primary Examiner — Dion R Ferguson

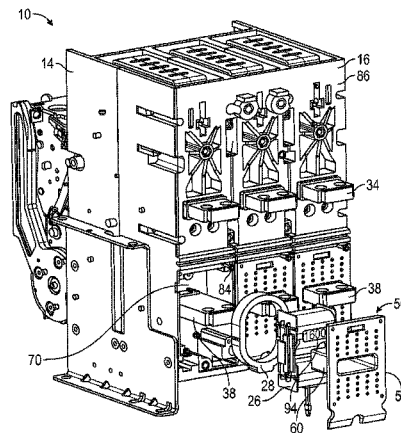
Assistant Examiner — Mandeep S Buttar

(74) *Attorney, Agent, or Firm* — GE Global Patent
Operation; Stephen G. Midgley

(57) **ABSTRACT**

A cover assembly for a circuit breaker includes a cover, the
cover including a first portion and a second portion. The first
portion is configured to at least partially cover a current
sensing element within the circuit breaker, and has an interior
surface and a cover opening. The second portion extends from
the interior surface of the first portion, and has a terminal
pocket opening aligned with the cover opening. The cover is
configured to receive a load terminal through the terminal
pocket opening and cover opening.

16 Claims, 6 Drawing Sheets



(56)	References Cited	CN	202564789	U	11/2012
		CN	202737346	U	2/2013
	FOREIGN PATENT DOCUMENTS	CN	202888095	U	4/2013
		CN	202888105	U	4/2013
CN	202434411	U	9/2012	* cited by examiner	

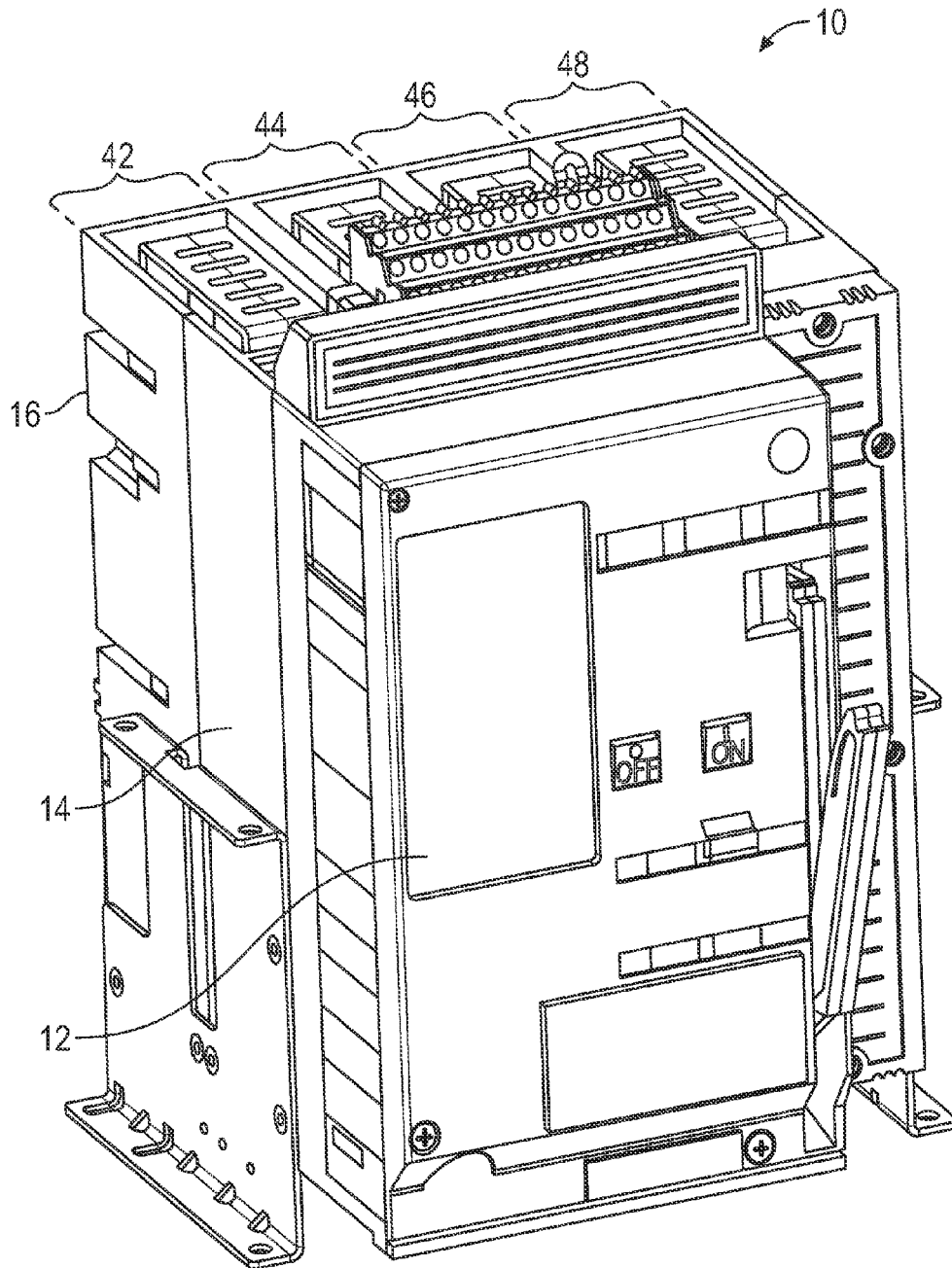


FIG. 1

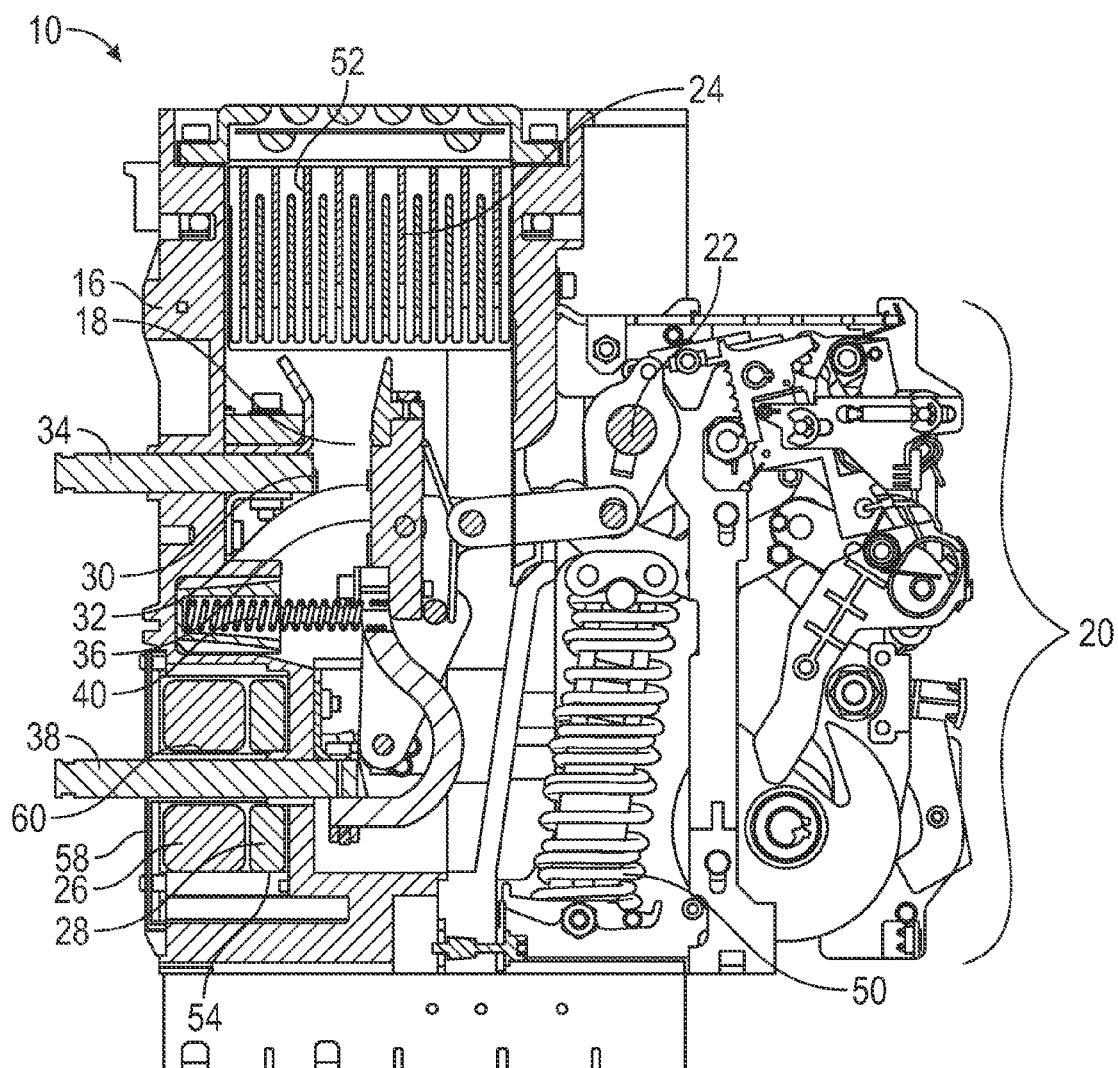


FIG. 2

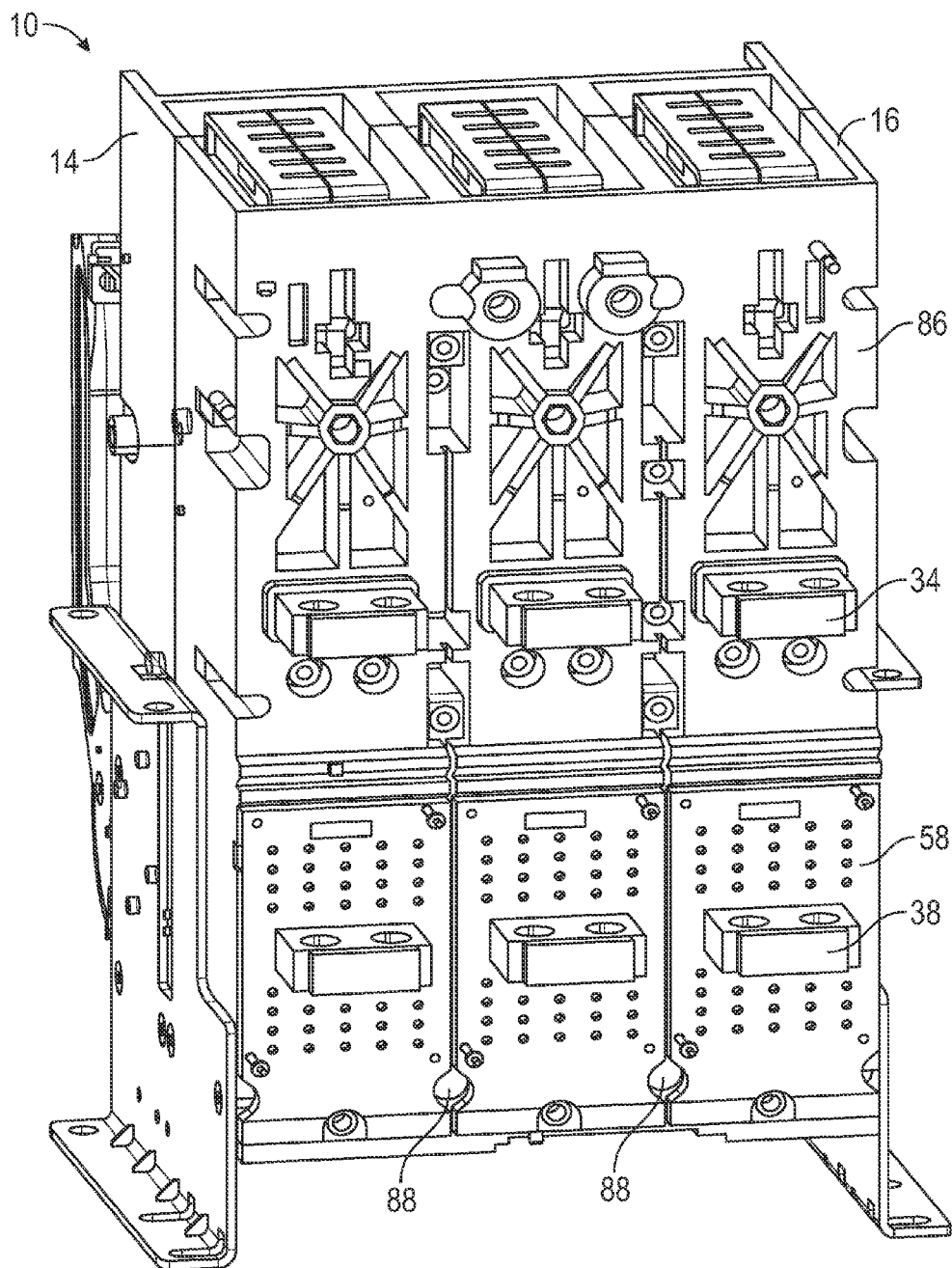


FIG. 3

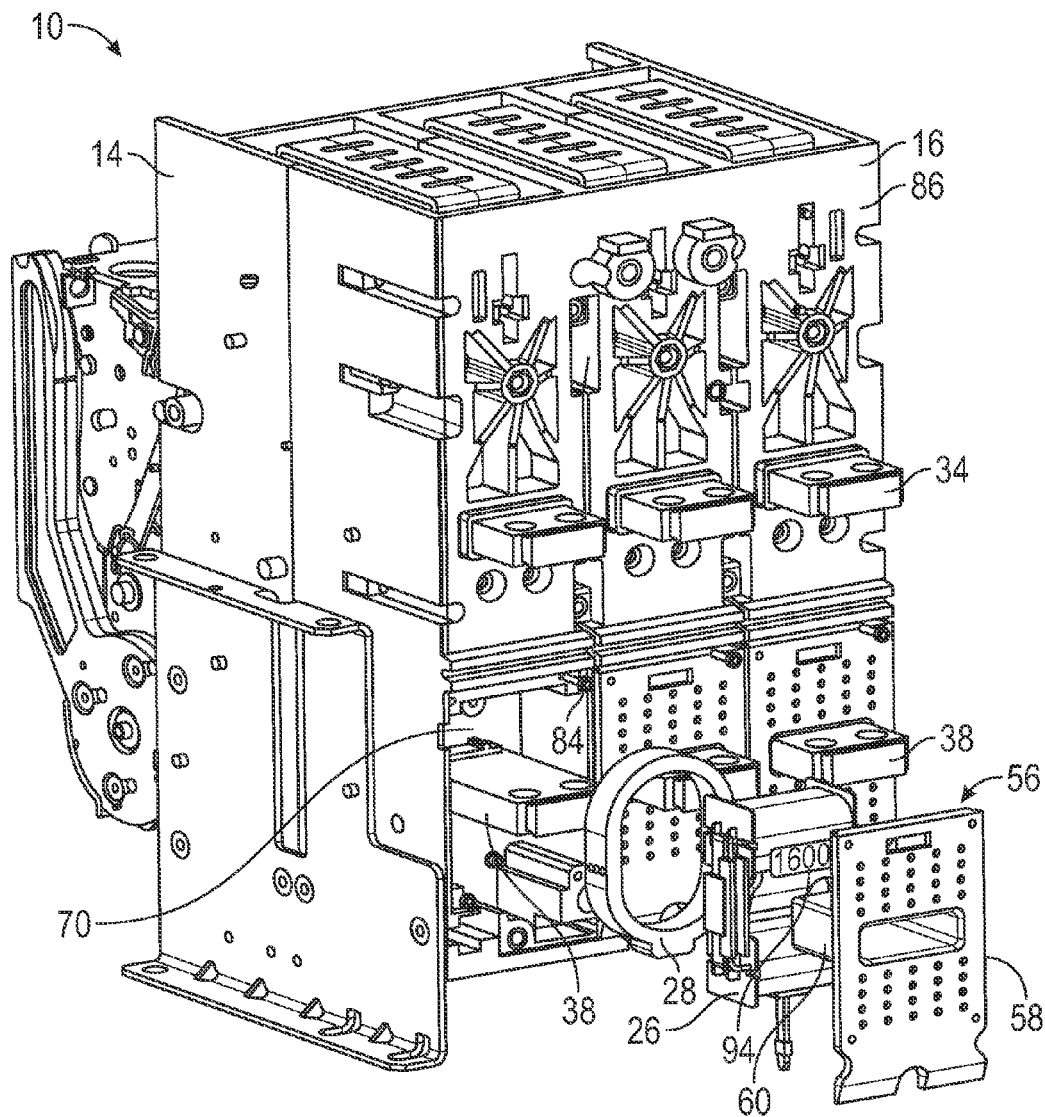


FIG. 4

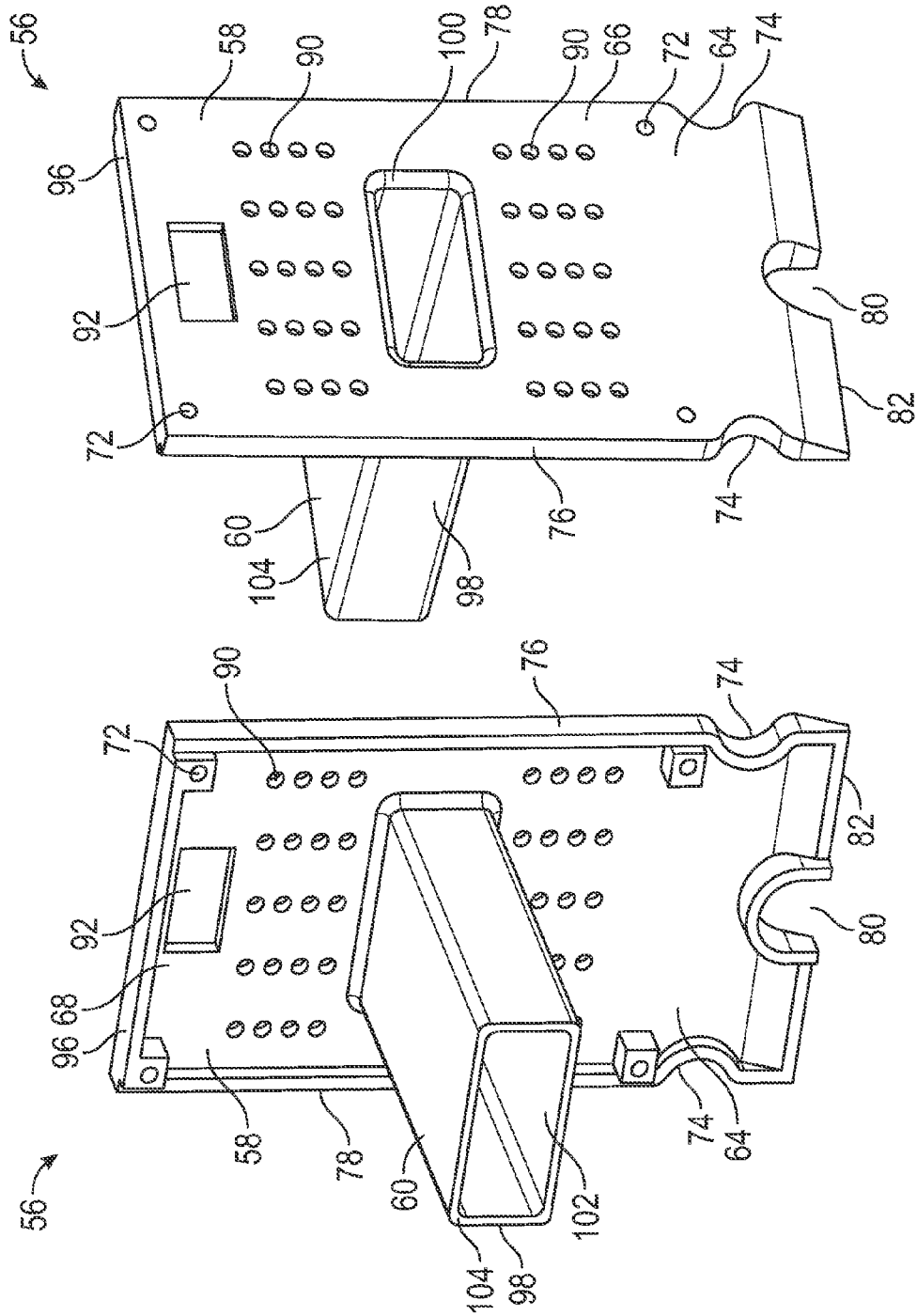


FIG. 6

FIG. 5

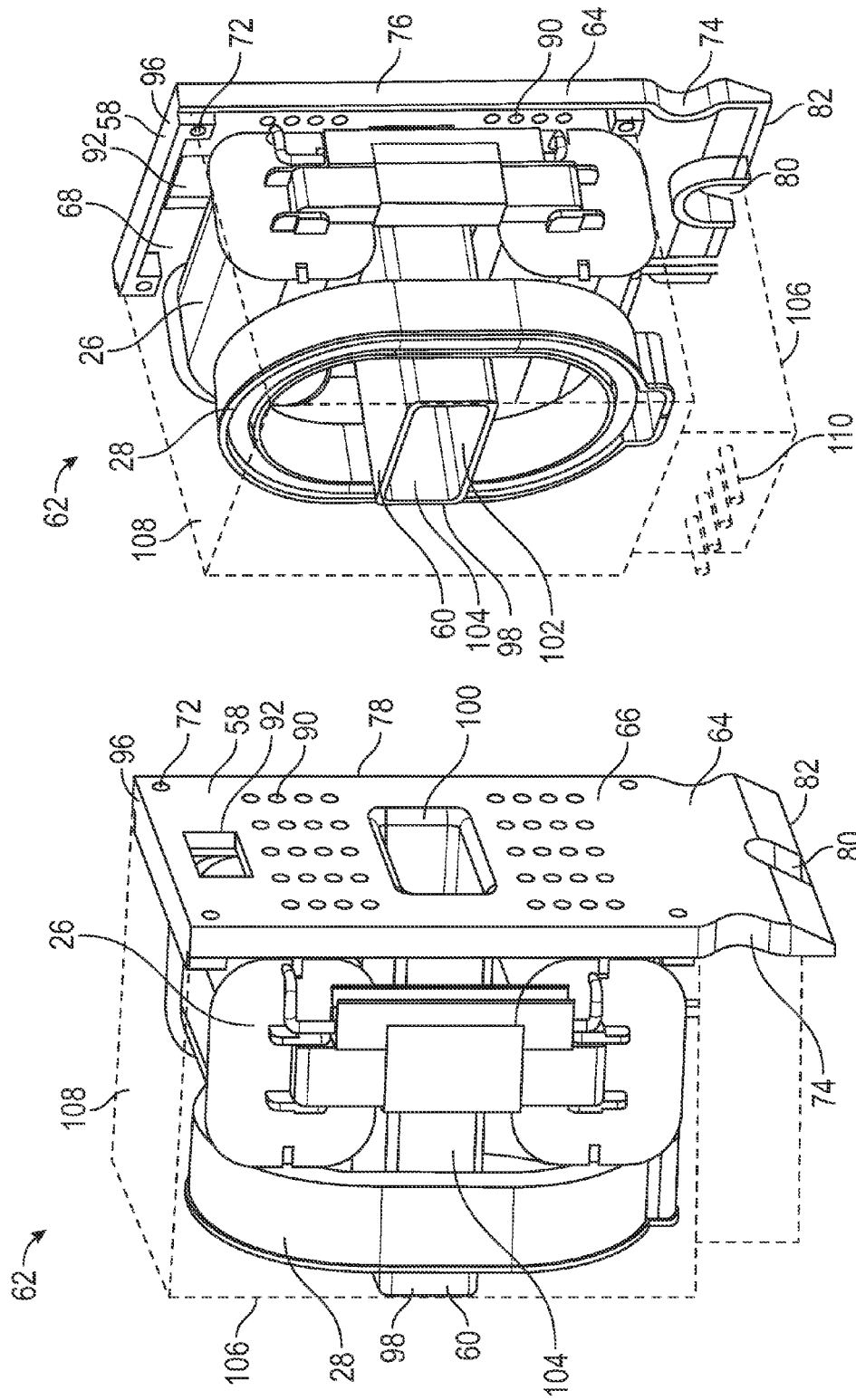


FIG. 8

FIG. 7

1

COVER ASSEMBLY FOR CIRCUIT BREAKER, CIRCUIT BREAKER HAVING THE SAME, AND METHOD

BACKGROUND OF THE INVENTION

The subject matter disclosed herein relates to a circuit breaker having a current transformer.

Circuit breakers are widely used to protect electrical lines and equipment. The circuit breaker monitors current through an electrical conductor and “trips” to open the electrical circuit and thus interrupt current flow through the circuit provided that certain predetermined criteria are met, such as an over-current condition. An electronic trip unit (“ETU”) is a device that is used in conjunction with a circuit breaker to control the current (and/or voltage) versus time trip response. The ETU is a programmable device which measures and times current flowing through the circuit breaker and initiates a trip signal when appropriate. The circuit breaker includes circuits that measure current in the device. Current-sensing transformers sense circuit current and provide current signals to the ETU for processing. Current transformers and Rogowski coils monitor the current in the circuit breaker. The current transformer is used for powering the ETU without use of external auxiliary power. The current transformer provides current output to the ETU that is proportional to the primary current flowing through it. Heat is developed due to current transformer losses. Rogowski coil is used for saturation free measurement of current in the conductor of the circuit breaker. Rogowski coil provides a voltage output that is proportional to the time derivative of the current, rather than a current output like traditional current transformers. To withstand certain impulse tests, insulating tape is pasted on the load terminal.

BRIEF DESCRIPTION OF THE INVENTION

According to one aspect of the invention, a cover assembly for a circuit breaker includes a cover, the cover including a first portion and a second portion. The first portion is configured to at least partially cover a current sensing element within the circuit breaker, and has an interior surface and a cover opening. The second portion extends from the interior surface of the first portion, and has a terminal pocket opening aligned with the cover opening. The cover is configured to receive a load terminal through the terminal pocket opening and cover opening.

According to another aspect of the invention, a circuit breaker includes at least one current sensing element, a load terminal, and a cover assembly. The cover assembly includes a cover having a first portion and a second portion. The first portion is configured to at least partially cover the at least one current sensing element within the circuit breaker, and has an interior surface and a cover opening. The second portion extends from the interior surface of the first portion, and includes a terminal pocket opening aligned with the cover opening. The load terminal is received within the second portion, through the terminal pocket opening, and through the cover opening.

According to yet another aspect of the invention, a method of insulating a load terminal from a current sensing element within a circuit breaker includes employing a cover assembly, the cover assembly having a cover including a first portion and a second portion, the first portion having an interior surface and a cover opening, and the second portion extending from the interior surface of the first portion, the second portion having a terminal pocket opening aligned with the

2

cover opening. The method also includes installing the cover assembly on the circuit breaker by passing the terminal pocket opening of the second portion of the cover over the load terminal of the circuit breaker, and at least partially covering the current sensing element with the first portion of the cover.

These and other advantages and features will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The subject matter, which is regarded as the invention, is particularly pointed out and distinctly claimed in the claims at the conclusion of the specification. The foregoing and other features, and advantages of the invention are apparent from the following detailed description taken in conjunction with the accompanying drawings in which:

FIG. 1 is a front perspective view of an exemplary embodiment of a circuit breaker;

FIG. 2 is a side cross-sectional view of an exemplary embodiment of a circuit breaker with an exemplary embodiment of a cover assembly;

FIG. 3 is rear perspective view of an exemplary embodiment of a circuit breaker with the cover assembly;

FIG. 4 is an exploded perspective view of an exemplary embodiment of the cover assembly with respect to the circuit breaker;

FIG. 5 is a perspective view of an exemplary embodiment of an interior of a cover for the cover assembly;

FIG. 6 is a perspective view of an exterior of the cover shown in FIG. 5;

FIG. 7 is a front perspective view of another exemplary embodiment of a cover assembly, with a housing shown in phantom; and,

FIG. 8 is a rear perspective view of the cover assembly of FIG. 7, with the housing shown in phantom.

The detailed description explains embodiments of the invention, together with advantages and features, by way of example with reference to the drawings.

DETAILED DESCRIPTION OF THE INVENTION

FIGS. 1-4 illustrate an exemplary embodiment of an electrical circuit breaker 10. The exterior perspective view of the circuit breaker 10 shown in FIG. 1 depicts an electronic trip unit (“ETU”) 12, front housing 14, and rear housing 16. The circuit breaker 10 includes four phases 42, 44, 46, and 48, however alternate numbers of phases may be included in the circuit breaker 10, such as, but not limited to, three phases, as shown in FIGS. 3-4. The side cross-sectional view of the circuit breaker 10 shown in FIG. 2 depicts a contact system 18, operating mechanism 20, lay shaft 22, arc chamber 24, current transformer 26, Rogowski coil 28, line terminal 34, and load terminal 38. The contact system 18, sometimes referred to as the current path or current carrying system of the circuit breaker 10, includes fixed and moving contacts 30, 32. The fixed contact 30 is electrically connected to the line terminal 34, and the moving contact 32 is supported by a movable contact finger 36 which is electrically connected to the load terminal 38. In a normal “on” or closed condition of the circuit breaker 10, the fixed and moving contacts 30, 32 are physically connected to each other due to applied mechanical pressure on the moving contacts 32. In an “off” or open condition of the circuit breaker 10, the moving contacts 32 are separated, via opening spring 40, from the fixed contacts 30, as illustrated in FIG. 1. The contact system 18 makes

or breaks the circuit based on current conditions, carries rated current without over heating, provides adequate contact pressure and depression to keep the contacts **30**, **32** closed in normal conditions, provides sufficient force to open contact system **18** with desired velocity during abnormal condition, and provides dielectric isolation when contacts **30**, **32** are in an open condition.

The front and rear housings **14**, **16** of the circuit breaker **10** provide structural stability against short circuit forces, dielectric stability and isolation between the phases **42**, **44**, **46**, **48**, and mounting means for other subsystems within the circuit breaker **10** such as, but not limited to, the contact system **18**, operating mechanism **20**, and lay shaft **22**.

The operating mechanism **20** serves as a storing energy device for the circuit breaker **10**. The operating mechanism **20** includes an arrangement to store potential energy which is released if a switching signal is sent to the breaker **10**. The potential energy can be stored in the circuit breaker **10** such as by deforming the main operating mechanism spring **50**. Alternatively, potential energy is stored by compressed air, by hydraulic pressure, etc. Once this stored energy is released in the form of kinetic energy, the moving contact **32** moves since the moving contacts **32** are mechanically attached through linkages to the lay shaft **22**, also referred to as a drive shaft, and then to the operating mechanism **20**. The lay shaft **22** acts as a connecting member between the operating mechanism **20** and the contact system **18** and helps to transfer the motion from operating mechanism **20** to the contact system **18**.

The arc chamber **24**, also referred to as a quenching device or arc chute, includes a high dielectric housing material with arc plates **52** assembled substantially parallel to each other. When the moving contacts **32** open and move away from the fixed contacts **30**, arc is generated. The arc is guided and wraps back and forth between the arc plates of the arc chamber **24** until it is extinguished or quenched in the arc chamber **24**.

The ETU **12** includes microprocessor platforms configured to ensure reliable protections. Different protection such as overload, short circuit, and residual (ground fault) protection are possible with ETU **12**, and can be programmed to accommodate different requirements. The circuit breaker **10** further includes at least one current sensing element **54**, such as the current transformer **26** and the Rogowski coil **28**. The current transformer **26** is used for powering the ETU **12** without use of external auxiliary power. The Rogowski coil **28** is used for saturation free measurement of current in the conductor of the circuit breaker **10**. The current sensing elements **54** are required for sensing the current and then allowing the ETU **12** to provide protection. An alternating current in a conductor develops magnetic field and the interaction of this field and Rogowski coil **28** local to the field gives rise to an induced voltage within Rogowski coil **28** which is proportional to the rate of change of current being measured.

The current sensing elements **54**, including the current transformer **26** and Rogowski coil **28**, should not touch the load terminals **38** to avoid failure of an impulse test, such as a 12 kV impulse voltage withstand test. It has been determined herein, however, that the addition of insulating tape to the load terminal **38** accounts for variations and adds to assembly time. Such insulating tape also increases the number of parts and inventory required to manufacture and assemble the circuit breaker **10**. In view of these issues, the circuit breaker **10** includes a cover assembly **56** including at least a cover **58**, or sensor cap, with integrated terminal pocket **60**, which serves as an insulation or isolation feature.

An exemplary embodiment of the cover assembly **56** including the cover **58** is shown in greater detail in FIGS. 5-6.

FIGS. 7-8 show another exemplary embodiment of a cover assembly **62** that includes the cover **58** in addition to the current transformer **26** and Rogowski coil **28**. In either embodiment of the cover assembly **56**, **62**, the cover **58** with integrated terminal pocket **60** avoids the impulse failure test with respect to load terminal **38** and current transformer **26**, and due to space constraints within the circuit breaker **10**, is sized such that the terminal pocket **60** fits between the load terminal **38** and the current transformer **26** and Rogowski coil **28**.

In the illustrated embodiment of the cover **58**, the cover **58** includes a first portion **64**, which may be substantially planar, having an exterior surface **66** and an interior surface **68**. When installed, the exterior surface **66** is exposed while the interior surface **68** faces an interior **70** (FIG. 4) of the circuit breaker **10**. The first portion **64** is provided with at least one securing aperture **72** for passage of a securing member, such as a screw there through to secure the cover **58** onto the rear housing **16**. The first portion **64** may further include indented sections **74** on opposing first and second sides **76**, **78**, as well as an indented section **80** on a third side **82**, for accessing securement members within the circuit breaker **10**. The third side **82** may further be tapered as shown. The cover **58** is formed of an insulative material, such as, but not limited to, thermoplastic or thermal polymer. When installed onto mating receiving apertures **84** of the rear housing **16** (see FIG. 4) the first portion **64** is arranged to be substantially flush with other cover assemblies **56**, **62** assembled on the circuit breaker **10**, and may additionally be substantially flush with a rear surface **86** of the rear housing **16**. Indented sections **74** on adjacent first and second sides **76**, **78** of the first portions **64** together form a substantially circular space **88** (FIG. 3). While the covers **58** are illustrated as separated in FIGS. 4-8, in another exemplary embodiment, any number of the covers **58** may be integrally attached with the first sides **76** attached to the second sides **78** of adjacent covers **58**. For example, if the circuit breaker **10** is a three pole circuit breaker, three covers **58** may be integrally attached to each other, and if the circuit breaker **10** is a four pole circuit breaker, four covers **58** may be integrally attached.

Because the current transformer **26** gets heated during normal operation, and this local heat adds to overall heat developed by the breaker **10**, venting holes **90** are provided in the first portion **64** of the cover **58** to provide ventilation to dissipate this heat. As shown, the venting holes **90** are arranged in rows and columns, and substantially evenly distributed about the first portion **64**, although alternate patterns for a venting arrangement would also be within the scope of these embodiments. The first portion **64** of the cover **58** may further include a window **92** provided to view the rating **94** (FIG. 4) of the current transformer **26** to the user after assembly. The window **92** is provided in the cover **58** such that when the cover assembly **56**, **62** is installed, the window **92** is aligned with and overlaps the rating **94** on the current transformer **26** so that the rating **94** is visible through the window **92**. As illustrated, the window **92** is located adjacent a fourth side **96** of the first portion **64**, opposite the third side **82** of the first portion **64**, and substantially centrally disposed between the opposing first and second sides **76**, **78**, however the window **92** may be positioned wherever the rating **94** is provided on the current transformer **26**.

A second portion **98** of the cover **58** includes the integrated terminal pocket **60** that extends from the interior surface **68** of the first portion **64** of the cover **58**. The second portion **98** may be substantially perpendicular to the first portion **64**. The terminal pocket **60** is tubular shaped, and is configured to have an interior cross-sectional shape that is slightly larger

5

than an exterior cross-sectional shape of the load terminal 38 such that the load terminal 38 may easily pass there through. As shown, the terminal pocket 60 and the load terminal 38 may each have a substantially rectangular cross-section. The first portion 64 further includes a cover opening 100 aligned with terminal pocket opening 102 of terminal pocket 60. The cover opening 100 is illustrated as disposed substantially centrally between the first and second opposing sides 76, 78 and third and fourth opposing sides 82, 96, but may be positioned at a location most convenient for the load terminal 38 to pass there through.

When installed, the terminal pocket 60 will pass through the current transformer 26 and the Rogowski coil 28 as shown, with the current transformer 26 and the Rogowski coil 28 surrounding the outer periphery of the terminal pocket 60. The inner periphery of the terminal pocket 60 will surround the load terminal 38. Thus, the current transformer 26 and Rogowski coil 28 are separated from the load terminal 38 by a wall 104 of the terminal pocket 60. As the terminal pocket 60 forms a part of the cover 58, it is also made of an insulative material to provide isolation of the load terminal 38 from the current transformer 26 and Rogowski coil 28.

Turning to FIGS. 7-8, the cover assembly 62 is shown with the current transformer 26 and the Rogowski coil 28 disposed within a housing 106 that extends from the interior surface 68 of the first portion 64 of the cover 58. The current transformer 26 and the Rogowski coil 28 may be disposed within the housing 106 and potted therein with a potting compound 108, such as, but not limited to, an epoxy resin. The housing 106 includes connector elements 110 configured to connect the cover assembly 62 within the circuit breaker 10. The connector elements 110 may extend outwardly from the housing 106 as shown for insertion within female receptacles within the circuit breaker 10. Alternatively, the connector elements 110 may include female receptacles configured to receive male connectors of the circuit breaker 10, or may include a combination of female receptacles and male connectors. In any case, the cover assembly 62 with cover 58, housing 106, current transformer 26 and Rogowski coil 28 is employable as an integral unit for insertion into, or removal from, the circuit breaker 10. In yet another exemplary embodiment, a current sensing structure having a housing with current transformer 26 and Rogowski coil 28 contained therein may be positionable onto the cover 58 of the cover assembly 56 of FIGS. 5-6, with the terminal pocket 60 threaded into an aperture in the housing of the current sensing structure, to arrive at the cover assembly 62 of FIGS. 7-8 to subsequently employ the cover assembly 62 as an integral unit. Also, while the above-described embodiments have been described as including both the current transformer 26 and the Rogowski coil 28, in alternate embodiments, only one of the current transformer 26 and Rogowski coil 28 is included in either the circuit breaker 10 or the integrated cover assembly 62.

By providing the cover assembly 56, 62 with the load terminal pocket 60 as described within the exemplary embodiments of the cover assembly 56, 62, some advantages that may be realized in the practice of some embodiments include the simplified assembly of the cover assembly 56, 62 with the circuit breaker 10 by eliminating the need to separately install insulating tape on the load terminal 38. Fewer parts are required, which additionally reduces inventory requirements. Additionally, because the cover assembly 56, 62 is pre-formed with the load terminal pocket 60, variations that may be experienced with insulating tape are eliminated. When the cover assembly 62 includes the current transformer 26 and Rogowski coil 28 together as an integral unit, further advantages including efficiency and simplicity are realized.

6

The use of the terms first, second, etc. do not denote any order or importance, but rather the terms first, second, etc. are used to distinguish one element from another. Furthermore, the use of the terms a, an, etc. do not denote a limitation of quantity, but rather denote the presence of at least one of the referenced item. While the invention has been described in detail in connection with only a limited number of embodiments, it should be readily understood that the invention is not limited to such disclosed embodiments. Rather, the invention can be modified to incorporate any number of variations, alterations, substitutions or equivalent arrangements not heretofore described, but which are commensurate with the spirit and scope of the invention. Additionally, while various embodiments of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

The invention claimed is:

1. A cover assembly for a circuit breaker, the cover assembly comprising:

a cover, the cover including:

a first portion configured to at least partially cover a current sensing element within the circuit breaker, the first portion having an interior surface and a cover opening; and, a second portion extending from the interior surface of the first portion, the second portion having a terminal pocket opening aligned with the cover opening;

wherein the cover is configured to receive a load terminal through the terminal pocket opening and cover opening; at least one current sensing element surrounding the second portion; and

a housing extending from the interior surface of the first portion of the cover, the at least one current sensing element disposed within the housing.

2. The cover assembly of claim 1, wherein the first portion further includes a plurality of venting holes arranged to dissipate heat from the current sensing element therethrough.

3. The cover assembly of claim 1, wherein the first portion further comprises a viewing window, the viewing window configured to align with a rating provided on the current sensing element.

4. The cover assembly of claim 1, wherein the second portion is substantially perpendicular to the first portion.

5. The cover assembly of claim 1, wherein the first portion is substantially planar and the second portion is tubular.

6. The cover assembly of claim 5, wherein the second portion has a substantially rectangular cross-sectional shape.

7. The cover assembly of claim 1, wherein the at least one current sensing element includes a current transformer.

8. The cover assembly of claim 1, wherein the at least one current sensing element includes a Rogowski coil.

9. The cover assembly of claim 1, wherein the at least one current sensing element is disposed within the housing.

10. The cover assembly of claim 1, wherein the housing further comprises a connector element disposed thereon and configured to connect the cover assembly within the circuit breaker.

11. A circuit breaker comprising:

at least one current sensing element;

a load terminal; and,

a cover assembly, the cover assembly having a cover formed of an insulative material including:

a first portion configured to at least partially cover the at least one current sensing element within the circuit breaker, the first portion having an interior surface and a cover opening; and,

7

a second portion extending from the interior surface of the first portion, the second portion having a terminal pocket opening aligned with the cover opening; wherein the load terminal is received within the second portion, through the terminal pocket opening, and through the cover opening; wherein the current sensing element is isolated from the load terminal by the second portion; and wherein the cover assembly further includes a housing extending from the interior surface of the first portion, the current sensing unit is disposed within the housing, and the cover assembly and current transformer are insertable as an integral unit within the circuit breaker.

12. The circuit breaker of claim **11**, wherein the at least one current sensing element includes a current transformer.

13. The circuit breaker of claim **12**, wherein the current transformer includes a rating provided on the current transformer, the first portion includes a window, and the rating is visible through the window.

14. The circuit breaker of claim **12**, wherein the first portion includes a plurality of venting holes, the venting holes arranged to dissipate heat from the current transformer there-through.

8

15. A method of insulating a load terminal from a current sensing element within a circuit breaker, the method comprising:

employing a cover assembly, the cover assembly having a cover including a first portion, the first portion having an interior surface and a cover opening, and a second portion extending from the interior surface of the first portion, the second portion having a terminal pocket opening aligned with the cover opening;

installing the cover assembly on the circuit breaker by passing the terminal pocket opening of the second portion of the cover over the load terminal of the circuit breaker; and,

at least partially covering the current sensing element with the first portion of the cover, wherein the cover assembly includes the current sensing element and installing the cover assembly includes simultaneously installing the current sensing element and cover onto the circuit breaker.

16. The method of claim **15**, further comprising dissipating heat from the current transformer through venting holes in the first portion of the cover of the cover assembly.

* * * * *